FTD-MT-24-1144-71

FOREIGN TECHNOLOGY DIVISION

CONTEMPORARY STATE AND PROSPECTS FOR THE DEVELOPMENT OF WELDING IN MACHINERY CONSTRUCTION

by

G. A. Nikolayev

Approved for public release; distribution unlimited.

UNCLASSIFIED

Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) Foreign Technology Division Air Force Systems Command U. S. Air Force	2a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED 2b. GROUP

3. REPORT TITLE

CONTEMPORARY STATE AND PROSPECTS FOR THE DEVELOPMENT OF WELDING IN MACHINERY CONSTRUCTION

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

Translation

5. AUTHOR(S) (First name, middle initial, last name)

Nikolayev, G. A.

6. REPORT DATE 1970	7a. TOTAL NO. OF PAGES 9	7b. NO. OF REFS
8a. CONTRACT OR GRANT NO. b. PROJECT NO. c. DIA Task Nos. T65-01-82 and d. T65-01-83	9a. ORIGINATOR'S REPORT NUMBER(S) FTD-MT-24-1144-71 9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)	

10. DISTRIBUTION STATEMENT

Approved for public release; distribution unlimited.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY Foreign Technology Division Wright-Patterson AFB, Ohio

13. ABSTRACT

The today practised automatic welding methods were developed under the management of the Institute of Electric Welding Imeni E. O. Platon in coordination with many factories and scientific research institutes. By the end of the year 1970, nearly 60 percent of all welding constructions, the yearly capacity of hich is now 2.2 million tons, will be produced by automatic welding methods. The application areas of various welding methods, electric welding, flux welding, electroslag welding, electric resistance welding, and electronbeam welding are discussed. Problems of physical metallurgy of welding and working metals by help of plasma and other heat sources, mechanical and fatigue strength of welded joints and their resistance to corrosion and cracking are studied at many scientific research institutes and higher technical schools. Special investigations are conducted in the field of ultrasonic welding of metals and particularly polymers. The joining of organic tissues and bone elements has been made possible by recently developed methods using ultrasound in combination with liquid polymers. High qualified welding engineers are educated today at 44 higher institutes of learning. [AP1040378]

DD FORM 1 NOV 65 1473

UNCLASSIFIED

Security Classification

UNCLASSIFIED

Security Classification

KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Welding Technology Weld Joint Evaluation Metallurgic Process Training Polymer						

UNCLASSIFIED

Security Classification

EDITED MACHINE TRANSLATION

CONTEMPORARY STATE AND PROSPECTS FOR THE DEVELOPMENT OF WELDING IN MACHINERY CONSTRUCTION

By: G. A. Nikolayev

English pages: 9

Source: Izvestiya Vysshikh Uchebnykh Zavedeniy. Mashinostroyeniye (News of Institutions of Higher Learning. Machine Building), No. 4, 1970, pp. 92-97.

This document is a SYSTRAN machine aided translation, post-edited for technical accuracy by: TSgt. Lee D. Thompson.

UR/0145-70-000-004

Approved for public release; distribution unlimited.

PREPARED BY:

TRANSLATION DIVISION
FOREIGN TECHNOLOGY DIVISION
WP-AFB, OHIO.

CONTEMPORARY STATE AND PROSPECTS FOR THE DEVELOPMENT OF WELDING IN MACHINERY CONSTRUCTION

Doctor of Tech. Sciences, Prof. G. A. Nikolayev
(Moscow Higher Technical School named for N. E. Bauman)

Welding technology is based, mainly, on the use of electrical energy and was spread in our country only under Soviet authority in parallel with the increase in power resource. Its development is a direct consequence of V. I. Lenin's instructions on the development of power engineering. Welding was developed with considerable attention and aid from the side of the CC/CPSU (Central Committee of the Communist Party of the Soviet Union) and the Soviet government. By the solutions of the XVII party conference in 1932 the use of welding instead of riveting became not only recommended, but also necessary for a large group of metal structures. Since 1940 the manual welding process has been replaced by submerged arc welding developed under the guidance of the Institute of Electrical Welding named for Ye. O. Paton with the collaboration of Scientific Research Institutes and factories who preserve its leading value today. In 1958 the volume of submerged arc welding increased 2.5 times, and since 1966, progressive methods of welding and surfacing have expanded, and new scientific studies have been developed.

Structures of various types and alloys of steels and nonferrous metals, with the thickness of the walls from 1 to 50 mm under various screens are welded by electric arc. At the end of 1970 about 60% of all welding works with a total yearly volume of production

of welded structures of 22 million tons will be accomplished by automatic welding. Automatic installations in a medium of protective gases make it possible to lay joints in all attitudes; joints are welded at a rate of up to 200 m/h by submerged arc welding. Automatic installations have been created which work according to programs, on the principle of tracking with feedback, guaranteeing reliable fusion depth. Semiautomatic installations are used for laying short and scattered structures of joints.

Steel articles 50 and more mm thick are joined by arc-free electroslag welding. The problem is to create installations for electroslag welding in the absence of superheating of the metal, as well as with a good connection structure. The electroslag process makes it possible to create machine building heavy structures from combined small-scale blocks that are distributed during the manufacture of turbines, forging-and-pressing, and rolling equipment, boilers, containers, and mountings. The important problem is the reduction of the heat treatment operations of articles welded by the electroslag method.

Machines for resistance welding make it possible to butt weld articles with an area of several hundred square centimeters. The welding technique with continuous fusing is especially economical. Thick-walled pipes, chain links, etc.,are joined by this method. Connections by resistance welding are uniformly strong, as a rule, to the parent metal under static and vibration loads.

Parts 20-25 mm and more thick of two-three sheets are welded by spot resistance welding. Spot welding is very productive. From one installation it is possible to weld simultaneously 50 and more points. Spot welding finds extensive application in construction and transport machinery construction, in agricultural machines, and in instruments. One of the methods of improving spot welding is the use of projections.

Electron-beam welding is accomplished under vacuum conditions. It makes possible the laying of dagger joints with minimum depth of fusion of the parent metal even in closed spaces. Electroslag and

electron-beam welding are the ancestors of the analogous methods of remelting steels which make it possible to obtain refined metal.

The work experience of recent years showed the complete possibility of welding heat treated steels. It has been established that the presence of a narrow zone of tempered metal does not cause decreases in the strength of the joints. The problem of soldering in heat treating furnaces, salt inductor baths was developed, making it possible to obtain high strength and reliable soldered joints. As a rule, they possess a smaller stress concentration and greater density as compared with the welded joints. They make up rational honeycomb structures. The actual problem is the certain expansion of the use of soldering in metal structures, in particular in articles which require tight joints.

A number of new forms of welding has been developed, for example with radio-frequency currents which makes it possible to lay straight and circular joints on articles made of carbon steel 5-6 mm thick, at a rate of more than 50 m/min. An important problem is to provide for stable properties of connections of different metals. For special targets friction welding, diffusion welding, and explosive welding are used. A number of welding techniques has been developed for joining polymers.

Building-up, manual and mechanized, is not only used for the repair of articles, but also as a technological process during the manufacture of new structures. The volume of automated building-up has been increased considerably. Building-up is accomplished in various ways, in particular, in a vacuum.

Thanks to the development of fluxes the possibility has been achieved for the effective cutting of austenitic steel, slagged material, and reinforced-concrete structures. Lance flux cutting makes it possible to cut blocks of practically unlimited thickness. Semiautomatic reinforced-concrete plates tens of centimeters thick are cut easily. Plasma cutting processes are effective. With the aid of plasma, build-ups of surfaces with hard metals are produced.

The further spread of the sphere of application of welding in machinery construction is necessary because of the replacement of castings and forgings by fabricated structures, in particular in individual and small batch production, with the involved shapes of large-scale articles, in engine beds, in machine mountings, in the structures of turbines, in drums, flywheels, blocks, etc., considering the use of drop forgings, thin sheet material, and contact welding.

It has been a long established fact that in rationally designed welded structures, under a high quality technological process and in particular in the absence of low temperatures, brittle ruptures do not take place. The works of scientists of the AS USSR (Academy of Sciences Ukrainian SSR), the Moscow Higher Technical School named for Bauman, the All-Union Scientific Research Institute of Transportation Construction, the All-Union Scientific Research Institute of Hard Alloys, the All-Union State Scientific Research Institute for the Planning, Research, and Testing of Steel Structures and Bridges, and others determined the conditions that provide for prevention of the tendencies of welded structures towards the formation of cracks in them. Conditions have been studied that determine the possibilities of the conception and spreading of cracks, the resistivity of weld junctions to ductile fractures. Recommendations have been formulated for the heat treatment of welded structures to increase the ductility which hinders the spreading of cracks. Brands of steel have been determined, considering their heat treatment, the use of which in welded structures guarantees the absence of brittle ruptures at low temperatures from different positions: the reserve of strength over the temperature range of brittleness, in the value of the stress limits and maximum plastic deformations. The Central Scientific Research Institute of Heavy Machinery, the Moscow Higher Technical School, and others developed measures for strengthening weld joints by surface treating them by creating compression stresses by rolling and other means.

A number of experiments has been conducted on the problem of residual stresses and deformations during welding. In recent years theoretical methods for defining weld stresses in thin-walled and

thick-walled articles have been developed considering the elasto-plastic deformations, the change in the physico-mechanical characteristics of material with use of an electronic computer. The triaxial fields of residual stresses during welding and the influence of various forms of heat treatment for removing them have been studied, along with residual deformations and stress during the welding of alloyed steels and alloys, considering the structural changes during heating and cooling. The combination of factors, at which the residual stresses are safe for the strength of the welded structures and, on the contrary, at which localization of the plastic deformations in concentrators gives rise to the emergence of destruction has been established.

Before welders-machinery builders stands the problem of deepened research on the welding processes and the micromechanics of weld seams considering the theory of dislocation; illumination of the nature of the formation of initial destruction, the development of methods to eliminate them; research on the processes of residual deformations of embossing welded structures; development of expeditious construction forms in accordance with the requirements of the technological processes; requirements of the mechanical engineers for planning new welding equipment, in particular for contact welding, and also for automatic and semi-automatic arc convenient for use when welding different articles and for installing them in continuous automated and mechanized lines; on the development of all possible equipment for the automation and mechanization of the auxiliary associated welding processes.

Scientific research works in welding are conducted in the USSR by a large group of scientific research institutes, the laboratories of factories, departments of higher educational schools. All works are coordinated by the head Institute of Electric Welding named for Ye. O. Paton.

Questions on electric welding equipment, the development of new equipment is accomplished by the All-Union Scientific Research Institue of Electric Welding Equipment, using the factory "Electrik"

["Electrician"] as a base. The equipment for the gas-flame treatment of materials is studied in All-Union Scientific Research Institute of the Gas Welding Industry. The development of automatic and semi-automatic equipment for gas cutting and welding, the spraying of hard metals, and other processes is accomplished in this institute.

In the Institute of Metallurgy of the AS USSR the physical processes during the treatment of metals with plasma and other heat sources, the metallurgical processes during welding, and questions of welding metallography are studied. In the branch Scientific Research Institute TsNIITMASh (Central Scientific Research Institute of Heavy Machinery) a wide complex of works is accomplished in improving the processes of arc and resistance welding, friction welding that conforms to the designs of heavy machinery construction: turbines, boilers, etc. Scientific research is conducted in a large plan on establishing the structural strength of heavy machinery construction and methods of increasing their strength, in particular the weld junctions, predominantly by methods of surface treatment. Methods for welding nonferrous alloys and steels, predominantly of the high-strength martensite class, and also of austenitic, mainly of low thickness, using the most advanced methods of welding are developed.

In the Central Scientific Research Institute of Structural Parts named for V. A. Kucherenko, in the Central Scientific Research Institute of Construction of the Ministry of Transportation Construction (Mintransstroy), in the TsNII of Proyektstal' konstruktsiya research is conducted on the fatigue and brittle strength of welded structures, on the study of strength characteristics, and on the work of welded structures under operating conditions.

A large role in the advancement of the science of welding is played by departments of many schools of higher learning: the MVTU (Moscow Higher Technical School) named for Bauman, the Leningrad Polytechnical Institute named for M. I. Kalinin, the Moscow Aviation-Technological Institute, the Rostov Institute of Agricultural Machinery Construction, the Chelyabinsk Polytechnical Institute, etc.

At the MVTU named for Bauman scientific experiments are conducted in a number of the scientific directions. Many works are conducted in the area of the strength of welded structures: construction, corrosion, fatigue, and brittle work under conditions of low temperatures, technological in the process of the production of welding works. The influence of defects on the mechanical properties of the joint is studied. The reliability of welded structures, considering the development of the technical processes of welding, and recently, also soldering is studied.

Numerous complexes of works on deepening the theory of the formation of welding deformations and stresses, factors which facilitate brittle destruction, conditions which determine the distribution of the cracks are produced. New equipment is developed for automatic welding in a medium of protective gases of the joints of rotating and fixed pipes and thin-walled structures in the form of plates and casings. Over a number of years contact capacitor machines were developed and are being developed, presently most attention is directed to welding of the parts of microradioelectronics. Semiautomatic machines and technological processes for separating cutting of different metals, alloys, and nonmetallic materials are being developed.

Research is conducted in the field of the ultrasonic welding of metals and especially polymers. Ultrasonic welding with points, longitudinal and contour joints in toys and packing tare has been successfully introduced.

In recent years the welding engineers of the MVTU displayed interest in the processes of joining and separating not only materials, but also organic tissues. With the aid of ultrasound in conjunction with liquid polymers the possibility of connecting bone elements has been achieved. In bone breaks there is the possibility of connecting bone transplants with the aid of ultrasound and liquid polymers which makes it possible to install and hold down in the required position the fragments of bone up to the moment of the formation of calluses.

It proves to be possible with the aid of ultrasound to accomplish the processes similar to fusing, - to restore the separated bony tissue, replacing them with conglomerates of auto- and heterogranulated bone powder. The latter are applied on rigid bases, and with the aid of ultrasonic vibrations and liquid polymers they are converted into compact blocks which enter into the composition of the bones.

Ultrasound makes it possible to accomplish the cutting of bones and tendons with the use of a specialized instrument, according to developed technology, without causing harmful necrosis in this case. All the indicated research on the ultrasonic welding of organic tissues is accomplished by the MVTU together with prominent scientists physicians (Dr. of Medical Sciences, Prof. V. A. Polyakov and others) to whom a leading role in this matter belongs. It is difficult to predetermine, in which direction these studies will be developed in the future as far as these methods can be transferred from the laboratory on animals into the clinic, however the establishment of communications between the engineers and the physicians on this base, as it seems to us, has an unconditional interest.

Recently scientific organizations on welding in the city of Moscow combined. A scientific-research institute on welding based on university departments has been created. This SRI (Scientific Research Institute) works on public principles. In it are: the MVTU namved for Bauman, MATI (Moscow Aviation Technological Institute), MEI (Moscow Power Engineering Institute), MAI (Moscow Aviation Institute named for Sergo Ordzhonikidze), Institute of the Meat and Milk Industry, Institute of Electronic Machinery Construction, Institute of the Petroleum and Gas Industry. Work is conducted in close association with the EWI (Electrical Welding Institute) named for Ye. O. Paton, the Rostov Institute of Agricultural Machinery Construction, the Moscow Construction Engineering Institute, etc. The SRI organized a weekly seminar at the MVTU named for Bauman, the department for raising the qualifications of engineers and technicians at the MATI, academic council for the protection of candidate and doctoral dissertations at the MVTU. The SRI with the efforts of several departments issues scientific works, organizes periodic conferences

on the scientific research work of the schools of higher learning: the development of welding science, raising the qualifications of the instructors, attracting aspirants and students to scientific work.

A large quantity of scientific works of applied value is accomplished in the laboratories of the various enterprises. The experience of these works is generalized by the branch SRI's and by the head Electrical Welding Institute named for Ye. O. Paton.

Welders of the USSR take part in the work of the International Institute on Welding. Representatives of the Soviet Union direct to conferences of the Congress materials on accomplished works and come out with reports.

The basic problem of the workers of the schools of higher learning on welding, just as also in all other welding organizations, is accomplishment. The resolution of the CC/CPSU and the Council of Ministers in 1966, indicated earlier, deals with the preparation of highly skilled welding engineers in the 44 schools of higher learning of our country on a machinery construction and metallurgical base, the preparation and retraining of scientific personnel, all possible assistance for the introduction of the foremost welding science and technology into production.

For the 100th anniversary of the birth of V. I. Lenin the departments on welding of the schools of higher learning accepted a series of socialist obligations, one of which is participation in the Intercollegiate technological conference, as a result of which the basic ways of future progress in the field of welding in subsequent years should be mastered.